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Monterey, California

THE RAND STRATEGY ASSESSMENT SYSTEM AT
THE NAVAL POSTGRADUATE SCHOOL

by

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AND

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NAVAL POSTGRADUATE SCHOOL
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This Report describes the RAND Strategy Assessment System (RSAS) installation at the Naval Postgraduate School (NPS) with emphasis on improvements made to the installation at NPS over the past year, and to the upgrades provided by RAND Corp. The section on "Strategic Nuclear and Related Models has been expanded and updated. The RSAS attempts to combine the best features of political-military gaming and analytic modeling. The RSAS can be run in a near automatic mode with essentially two expert systems playing against each other or as an interactive game with human players. In between these extremes, the RSAS can be used as an analytic tool to suppport research and instruction. RAND has upgraded the naval models over the past year, but they are not yet completely developed to the satisfaction of Navy users. The Navy should continue to encourage development of maritime models and continued in-house expertise in the use of the system. When fully operational the RSAS will be a unique system that will aid Navy analysts and decision-makers who, for the first time, will have models that can represent every level and location of the political and military dimensions of warfare simultaneously.

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THE RAND STRATEGY ASSESSMENT SYSTEM
AT THE NAVAL POSTGRADUATE SCHOOL

by

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and
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of the original technical report, NPS-56-88-010, published in March 1988, re-written to satisfy the requirements of a DNA sponsored research project "Nuclear Assessments". The sponsor has the option of continuing to fund NPS RSAS activities or setting up a system at HQ DNA.

EXECUTIVE SUMMARY

This report describes the RAND Strategy Assessment System (RSAS) installation at the Naval Postgraduate School (NPS). The NPS RSAS first became operational in September 1987, and has continued to expand and improve as expertise is gained and the naval models are enhanced. The RSAS is a product of a multiyear effort by the RAND Corporation ("Improved Methods for Strategic Analysis") under the sponsorship of the Director, Net Assessment, in the Office of the Secretary of Defense (OSD/NA). The RSAS attempts to combine the best features of political-military war-gaming and analytic modeling. The RSAS is extremely flexible: it can be run in a near automatic mode with essentially two expert systems playing against each other, or it can be run as an interactive game with all the moves controlled by human players. In between these extremes, the RSAS can be used as an analytic tool to support strategy research and instruction, and as a wargaming support system.

Major models in the RSAS include Blue, Red, and Green agents playing the various nations, the Force Agent for simulating military operations, and the Control Agent that allows the analyst to control specific events, the scenario, timing, etc.. National Command Level models conduct high level decision-making, and Analytic War Plans carry out military operations for each side. The RSAS can currently conduct runs emphasizing strategic nuclear combat, Central European theater warfare, naval warfare to a certain degree, and air-land engagements in other "alternate" theaters. The current naval models have evolved to the

point where essential surface and strike warfare, ASW, and mining can be simulated; however, improvements in the naval models are required, as are additional models for the other aspects of naval warfare.

The software installation at NPS is RSAS release 3.5, running on two networked Sun micro workstations with a server, large hard-disk, tape drive, and printers in support. Secure space and housekeeping facilities are provided by the NPS Wargaming Analysis and Research Lab (WARLAB) of the Operations Research Department. RSAS and UNIX operating expertise is provided by the National Security Affairs Department. Future enhancements required for the system include an additional workstation, backup hard disks, an improved power supply, and a large screen display for instruction, briefing, and game purposes. Primary RSAS use at NPS is in support of research sponsored by those organizations that have funded the installation. Thus far the RSAS has been used to support student thesis research, classroom instruction, NSA faculty research, and some basic wargaming.

RSAS models are not yet completely developed to the satisfaction of Navy users. Rather than precluding future support of the RSAS, the Navy should continue to encourage development of maritime models and the attainment of in-house expertise in the use of the system. When fully operational, the RSAS will be a unique system that will aid Navy analysts and decision-makers who, for the first time, will have models that can represent most levels and locations of the political and military dimensions of warfare rapidly and simultaneously.

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Part I

INTRODUCTION

The RAND Strategy Assessment System (RSAS) was developed by the RAND Corporation under a project entitled "Improved Methods for Strategic Analysis." The work is sponsored by the Director, Net Assessment, in the Office of the Secretary of Defense (OSD/NA) in cooperation with the Office of the Joint Chiefs of Staff (OJCS), each of the Service Deputy Chiefs for Plans, Policy, and Operations, the Central Intelligence Agency (CIA), National Security Agency (NSA), and Defense Intelligence Agency (DIA). Representatives of these organizations make up the RSAS Steering Group.

Current holders of the RSAS include OSD/NA, OSD Program Analysis & Evaluation (OSD/PA&E), the Force Structure, Resource & Assessment Directorate of the Joint Staff (J-8), the Strategic Plans & Policy Directorate of the Joint Staff (J-5), the CIA Office of Soviet Affairs (SOVA), the Army Concepts Analysis Agency (CAA), the National Defense University War Gaming and Simulation Center (NDU-WGSC), the Naval Postgraduate School (NPS) National Security Affairs Department, the Naval War College Center for Wargaming, the Air University Center for Aerospace Doctrine Research & Education/Wargaming & Technical Analysis Division (AU/CADRE/WGTA), the U.S. Commander in Chief Pacific (USPACOM) J-55, the Army War College, DIA, and NSA. Organizations preparing to acquire the RSAS include the U.S. European Command (EUCOM), Air Force/XO, and the Army Intelligence Technical Analysis Center (ITAC). Additional users may be authorized by the

RSAS Steering Group at a later time.

Essentially a complex political-military simulation, the RSAS will eventually have the capability to handle all forms and phases of warfare, including intelligence and logistics, in a highly aggregated fashion. This will include the ability to play crises short of war, extended conventional war, nuclear war, conventional actions after nuclear strikes, war in space, war at sea, and all supporting political actions that supplement the armed conflict portion of war. The models are intentionally deterministic; hence plays may be repeated with the analyst making the choice of variables to be modified in order to do sensitivity analysis. Decisions are automatically logged according to analytic requirements.

NPS was selected to be the recipient of the Navy's first RSAS as a result of a meeting of the RSAS Steering Group in Santa Monica, California on 24-25 March 1986. This decision was recorded in a memorandum from the Director of Net Assessment/OSD, dated 12 May 1986, reporting the results of the conference. The initial hardware was obtained by NPS using $43,227 in 1987 NPS laboratory package resources to upgrade a Sun workstation on loan from the Naval Ocean Systems Center (NOSC) to the NPS Wargaming Analysis & Research Laboratory (WARLAB). The RSAS software, valued at some $31M, was provided by the Rand Corporation as authorized by the RSAS Steering Group. Other support for research has been provided for by $230,000 in Navy Direct Research Funding, and by $150,000 from the Defense Nuclear Agency research funding. The initial hardware has been upgraded and improved.

There are now two dedicated workstations, a file server, and a color printer in addition to the original large hard disk, high density tape unit, and laser printer, all networked together.

This report will provide a brief overview of the RSAS structure, the capabilities found in strategic nuclear, European and other land theater, and the naval models; how the RSAS is organized at NPS; and the opportunities for research. The appendices include a more detailed description of the hardware and software, the standard operating procedures for RSAS employment at NPS, specific restrictions due to security of the models and the database, and agreements with appropriate departments at NPS regarding maintenance and security. These appendices should be of interest to other authorized users when attempting to set up their own system.

The Defense Nuclear Agency (DNA) provided funds for this report. DNA can continue to fund the RSAS at NPS for research on subjects of interest to both the NPS and DNA or, alternatively, the DNA can purchase its own hardware, request delivery of the RSAS software through the RSAS Steering Group, obtain the necessary expertise to operate the system, and conduct its own research in-house.

Part II

THE RSAS CONCEPT

1. Methodology. The RSAS is the product of a multiyear effort which is attempting to improve the ability of strategy analysts by combining the best features of political-military wargaming and analytic modeling. This approach presents certain difficulties since war games usually address the asymmetries in conflict, the roles of non-superpowers, the nuclear forces, and the operational constraints, etc. Modeling, in contrast, tends to be more rigorous, and more inclined to a "what if?" type of approach. There are two important components in the RSAS approach: The use of decision models, and the procedures for analytic modeling.

The use of decision models to replace some or even all of the human decision making involved in game play both speeds play and requires a rigorous approach to the decisions being made. It also insures that the same decisions are always made for a given set of circumstances. Analysts and game players can still play all or part of the time, depending upon the requirements of the situation, by changing variables.

The second important component, the procedures for modeling the actual warfare, is embodied in the system of models called CAMPAIGN. CAMPAIGN is essentially the force agent for the RSAS, evaluating force operations and adjudicating combat. It uses a relatively high level of aggregation for forces, geography, and targets reflects increasingly higher asymmetries in terminology and operational concepts between Red and Blue, and captures parametrically some of the more complex military operations, such

as mobile missiles and communications sabotage. CAMPAIGN allows the user to set most major parameters into the simulation such as the yield of a nuclear weapon, or to script the results of "off-line" analysis such as the impact of chemical attacks on aircraft sortie rates.

In addition to permitting rapid testing of various scenarios and alternatives, the fast RSAS run time permits a "lookahead" in which the player or analyst can run a game within a game to test a plan using the entire gaming system to play against perceptions of the opponent. The "lookahead" tests the feasibility and acceptability of a specific plan, although the results may differ from subsequent runs due to misperceptions about the opponent or that the opponent simply chooses another alternative.

2. Models in the RSAS. Access to the RSAS is controlled by a government steering group. An unclassified version does not exist primarily because the system depends upon many sensitive databases. The major political agents in the RSAS are the Blue, Red, and Green representing NATO, the Warsaw Treaty Organization, and other countries, respectively. The Force Agent (CAMPAIGN), tracks military forces worldwide and assesses the results of force operations and battles. The third major agent is the Control Agent which assists the analyst in writing information displays, changing parameters, introducing exogenous events, and specifying the key events of a desired scenario. Each of these major agents and models is covered in detail below.

a. Red and Blue Agents. RSAS command, control and communication (C^3) models have been developed that represent the actual

organization and operation of NATO/U.S. and WTO/USSR C^3 functions. Command and Control (C^2) of forces is generally displayed in normal wartime position, i.e., there are generally no separate peacetime and wartime C^2 organizations. The functions of changing operational control from peacetime C^2 to wartime C^2, however, are generally accounted for within the RSAS. Thus, U.S. naval forces may be under the C^2 of NATO's Supreme Commander-Atlantic (SACLANT) for display purposes, but additional tableaus may show these forces as not available. Although such C^2 depiction is not absolutely correct, the emphasis on wartime functions for the RSAS did not warrant the additional expense and computer memory needed to depict correctly C^2 in both peacetime and war. Generally, the names used for NATO/U.S. Commanders-in-Chief (CINC's) correspond to reality, although a general command for forces in the continental U.S. was used instead of the multiple commands that actually exist. Actual CINC boundaries were also used.

For WTO/USSR theaters of military operations (TVD) commands, the best available data for names/boundaries are used, recognizing that in wartime these strategic directions will not necessarily follow pre-war expectations. Communications models used are classified and as accurate as possible, given the level of classification of the system. The RSAS architecture allows for more accurate portrayal of C^3, if required, to include data at extremely high levels of classification.

The Red and Blue agents for the RSAS each have a high level model termed the National Command Level (NCL) that emulates the highest authority for each agent - the National Command Authority

(NCA) for Blue, and the Defense Council for Red. The NCL selects escalation guidance, objectives, and strategies for each theater based upon the type of NCL selected by the analyst and a series of rules assessing the various NCL parameters to include the threat, the type and rapidity of decisionmaking, the status of superpower relations, etc. There are currently two different Red and two different Blue agents available in the RSAS; one set being more "hawkish" than the other.

A Global Command Authority (GCL) that represents the U.S./ NATO Joint Chiefs of Staff and NATO Military Committee, and the Soviet General Staff (VGK) then implements these decisions into specific plans to be run. The NCL models selected by the analyst can be modified or can be run on an automated basis. They can be used to run the game or can be studied as part of the research into national decision-making procedures.

b. Green Agent. The Green Agent is the RSAS model of non-superpower states which simulates national behavior in periods of superpower crises and open warfare. Countries modeled include the non-Soviet Warsaw Pact states, all NATO countries other than the U.S., as well as Japan, China, and numerous others. Green Agent is a rule based model which tests various conditions and takes actions based upon the rules of the system. Variables for each country include such items as alliance, orientation, temperament, assertiveness, opportunism, and nuclear capability. These variables can be set at the start of the game or changed during the game run. Outputs include a set of decisions or postures which control the actions of the armed forces of the country and access to its territory.

c. Control Agent. The Control Agent allows the analyst to schedule the writing out of information displays, to change selected parameters, to introduce exogenous events such as unconventional warfare, and to specify key events in the scenario, as required. The analyst can specify, for example, the day when nuclear warfare is to start, the loss of command posts to special forces action at specified times, and the degree of logging detail desired. The Control agent is extremely useful in adapting game play to the analytic or research requirements at hand. The Control Agent uses a System Monitor polling the decision models and a series of wakeup rules that are created when the analyst selects the various inputs noted above.

d. CAMPAIGN. CAMPAIGN is the global combat model providing a fully integrated treatment of conventional, theater-nuclear, and intercontinental nuclear warfare on a worldwide scale. CAMPAIGN is, in turn, part of the larger system that provides national level political models that deal with such issues as grand strategy, escalation, and war termination. CAMPAIGN, also referred to as the Force Agent, includes two models of operations: the main theater model (CAMPAIGN-MT) for Central Europe and Korea, and the alternate theater model (CAMPAIGN-ALT) for Northern and Southern Europe, Southwest Asia, with some initial work in other areas. CAMPAIGN is a time stepped model in which the length of the steps (one hour or less, up to 24 hours) are determined by the world situation, and by various wake up rules set by the players or by the system decision models. Most of CAMPAIGN-MT is run in a "C" language program called "Camper" which can also be

run in a stand-alone mode. In contrast, CAMPAIGN-ALT is written in RAND-ABEL. The heart of CAMPAIGN-MT is a collection of theater warfare, naval warfare, strategic warfare, and supporting models. These warfare models, usually developed separately to control complexity, contain significant interactions, sometimes using the same submodel for multiple purposes, e.g., dispersal of aircraft. Also, some model substitution can take place, e.g., RAND's TacSage for the normal air battle model. CAMPAIGN-MT is used for Central Europe and Korea, while the CAMPAIGN-ALT models are used for Northern and Southern Europe, the Middle East, Southwest Asia, and other areas under development. The RSAS database, the World Situation Data Set (WSDS), is divided into WSDS-A which supports CAMPAIGN-ALT, and WSDS-C which supports CAMPAIGN-MT.

3. Analytic War Plans. Blue analytic war plans (AWP's) are based upon the same base year as the databases (currently 1985). War plans do not derive from strategies used to support programming but rather from strategies based upon forces in hand. Historical files were used to create AWP's for earlier years. AWP architecture should support entering a wide variety of future or alternative current plans, and the architecture is generally compatible with that in current use by major CINC's. Red AWP's were developed using the best information available from national intelligence sources. Where alternative strategies are possible, a default strategy is provided, and in some cases alternative strategies (AWP's) can be selected. Should an analyst desire to

modify AWP's to reflect additional alternative strategies, procedures exist to exercise this option.

The AWP's in the RSAS are written in RAND-ABEL code, are relatively easy to read, and can be modified, although implementation of such modifications is not trivial. The AWP's are constructed in a modular fashion, using a phase, move, and order structure, together with bounds and wakeup rules for the various commands. AWP's can be controlled by the use of the Data Editor tableaux, although care must be taken with regard to changing the variables. AWP's receive authorizations to carry out actions from several sources including the NCL's or an analyst developed control plan, and produce as outputs orders to the force models, notification to higher authority, and announcements to the Green Agent.

4. Database and Software Tools. Database type information is contained in the notional World Situation Data Set (WSDS), containing entries in both RAND-ABEL (WSDS-A) and in the "C" programming language (WSDS-C). WSDS-A supports the Red, Blue, and Green Agent decision models, and CAMPAIGN-ALT. WSDS-C supports CAMPAIGN-MT. The analyst can interface with the system through the Control Panel, the Data Editor, the Hierarchy Tool, the Graphics Tools, CAMPAIGN Menu Tool (CMENT), the Logging Tools, and the Interpreter. These interfaces can be used to set and change inputs before and during the game, can be used to call and analyze data at any point during or after the game, and can be used to study in detail the logic and responses of the various models following each game.

Five of the software tools merit special mention:

a. Data Editor: The primary means of viewing and changing the many variables in the RSAS. It is used to set the initial values and game parameters, follow the game, alter the parameters during the game, perform post game analysis, and generate reports. Most commonly it is used to generate scenarios to include AWP selection, event timing, and exogenous event scheduling. It is made up of various Tableaux that can be selected and modified.

b. Cross Referencing Tool: For using or building rule based decision models. It can provide allowed values for variables, their locations, and comments regarding them.

c. Hierarchy Tool: Displays the RSAS hierarchy, depicting which entity is active at any given time during the game. Permits the game to be stopped when a particular entity is active, and can permit rules to be displayed regarding a selected actor. Useful for displaying the current command structure while the game is running, and indicating the active AWP for each command.

d. CAMPAIGN Menu Tool (CMENT): Interface into Force-C or CAMPER, providing more rapid access via walking menus, sliding table variables and a rolling ball globe for worldwide displays. CMENT is of major value in executing force orders, displaying force status, showing results of engagements, and depicting details of force interactions.

e. Interpreter: For changing and debugging RAND-ABEL codes interactively.

Analyst developed control plans have emerged as an important method for analysts to exercise control over the Force models.

Use of the control plans and the "INT" directory, as well as the "use" files, for Force orders allows great flexibility in RSAS support for specialized studies.

5. <u>Computer Factors</u>. The standard configuration for RSAS is the Sun Microsystem Sun Three color workstation operating under Sun's version of Berkeley UNIX, and using the "C" programming language. RSAS 3.5 requires at least 12 megabytes of workstation memory, and a minimum of 300 megabytes of disk space. Note that the files required by the system and the RSAS alone take up nearly 200 megabytes of storage. RSAS 3.5 has some 686,000 lines of source code (including 260,000 lines devoted to RAND-ABEL, and 180,000 to CAMPAIGN), and 120,000 lines of other support code, for a total of 806,000 lines of code. Typical scenario execution times include about one hour for twenty days of global war, and about forty minutes for twenty days of war in Europe. While the RSAS is currently programmed to run on the Sun workstations, it could be reprogrammed to work on other systems. The feasibility of other workstation options has been approved by the RSAS Steering group; however, recent studies indicate that cost considerations preclude a VAX/VMS modification, unless the potential user is willing to provide funds for such an extensive project.

Part III

STRATEGIC NUCLEAR AND RELATED MODELS

1. Strategic vs Theater. CAMPAIGN provides extensive "strategic" nuclear models for targeting, command, control, communications, and intelligence (C^3I), force operations, and battle damage assessment (BDA). These models are integrated into the overall CAMPAIGN structure, thus, "strategic" nuclear forces may be used in the theater campaign and may be damaged by the theater nuclear or the conventional campaign. "Strategic" and theater nuclear models share the same BDA models. For ease in communicating to Western readers, the more familiar use of the term "strategic" will be used in this report; i.e., intercontinental nuclear forces that are generally addressed in "strategic" arms control agreements. The reader is cautioned that this concept of "strategic" is not shared by the Soviet Union nor the Red agent in the RSAS.

2. Nuclear Forces. Nuclear capable forces can be used for strategic, operational, or tactical nuclear missions in any theater of warfare. Within CAMPAIGN, strategic nuclear missions are currently carried out by heavy bombers, land-based (ICBM) and submarine-launched (SLBM) ballistic missiles. British, French, and Chinese strategic forces, U.S. and Soviet mid-range missiles, and most nuclear capable aircraft other than heavy bombers are employed primarily for theater missions. Artillery fired atomic projectiles, very short range missiles, and nuclear aircraft committed to battlefield support are used for nuclear battlefield

missions. All strategic nuclear forces as well as operational and tactical nuclear forces can be used for theater nuclear missions. Tactical nuclear warfare at sea is an area that will need extensive upgrading in the future to represent fully the options available to each political-military agent.

Generally, nuclear forces are designed to execute preplanned targeting packages to handle various warfighting options that support the strategic, operational, or tactical objectives specified by the appropriate functional/area commanders. Strategic force execution requires connectivity to the National Command Authority (NCA). Theater nuclear forces use the same detailed delivery models used by the strategic forces, except that C^3 is not modeled explicitly and, instead, a nominal delay is inserted keyed to the force and the country executing. At the battlefield level, a simple delivery model is used with no C^3 delays.

3. Readiness. Levels of readiness are indicated by the force alert level, which is a fraction representing the percentage of aircraft and missiles ready for immediate execute. A default alert rate is assumed, but the analyst may vary these levels uniformly or by force type as required. Bombers and C^3 aircraft can be launched for airborne alert, and are supported by cycling and tanking. The combat readiness of SSBN forces is indicated by the number of SSBN's at sea. SSBN's are divided into groups and assigned to support a patrol region. The SSBN's cycle between their port and patrol area, and are integrated in with other naval movements in their ocean area. The number of SSBN's at sea can be increased by increasing the alert level for the SSBN's.

CAMPAIGN provides an automatic bomber "flush on warning" model to increase survivability, and calculates the number of surviving aircraft available for subsequent re-use.

4. <u>Operations</u>. Strategic nuclear forces can be alerted, dispersed, deployed, executed and damaged. Bombers can be launched for survival, ordered to their turn-around points, can be recovered, and reconstituted. Nuclear forces execute "nested" plans whenever they receive the appropriate authenticated communications (EAM's) which are disseminated from the NCL to the functional or regional groupings of forces. Once EAM's are received, missions are assigned to the individual weapons systems. In addition to the nested plans, nuclear forces can also be issued strike orders to execute. When launched, ICBM's and SLBM's are moved by a common missile movement model which is based upon great circle distance and speed with respect to the curvature of the earth. There is a parameterized ballistic missile defense model which extracts fixed attrition rates on incoming re-entry vehicles up to a selectable threshold. A space-based ballistic missile defense system is being added to the models for a future RSAS software release.

Bombers are assigned to predefined flight paths according to expected targeting plans, although the analyst may vary the predefined plans. Bombers are assigned tankers automatically as required, and are subjected to the simplified air defense model that allows for a fixed attrition rate for all enemy aircraft by region, or to a more fully developed air defense attrition model, if available. Bombers may release cruise missiles at the appro-

priate distances from their target, with the missiles having a greater probability of penetration than their parent bombers. All nuclear forces are subject to attrition during the conventional phase of a war. Modeling of recovery and reconstitution is limited at present. Currently, there is no provision for ICBM silo or SSBN reloads.

5. Strategic Command, Control, and Communications (C^3). The current nuclear C^3 models deal primarily with the ability of the NCA to communicate with strategic nuclear forces. Command and control decisions are made by the decision models of the full RSAS rather than by CAMPAIGN. Once a decision has been made, the C^3 model assesses the capability of the source command node to communicate with its destinations. The output of the C^3 model is an estimated time for correct message receipt and the fraction of each force connected. The model conducts a path search to find an acceptable path to destination and calculates the delay time via the nodes modeled in the C^3 models. If either end point node is destroyed, communications are not possible and the force ignores the order. If the nodes are damaged, the model measures the amount of time needed for repair. If the repair times are excessive, the transmission is considered blocked, and the applicable force ignores the order. If the source and destination nodes are operational, the model searches for a good path, selecting the first one that does not have an "excessive" delay. The Node Assessment Module calculates the time required to repair any damage to the node facilities, adds the processing time for a message, and also adds formatting time, message verification time, and force execution

time. The Link Assessment Module determines if the two nodes can communicate, and how much delay might be involved due to jamming and/or scintillation. The various alternative command posts and communications aircraft are modeled in RSAS and can become possible nodes in the network. Sustainability is also modeled, considering refueling, maintenance, and home base damage. Warning is partially modeled for strategic forces.

Space detection of missile launch is modeled as are certain communications paths. Tactical warning in CAMPAIGN serves to flush alerted aircraft and to advise the NCA. Strategic warning is specifically addressed by various political and military signals given by the Red, Blue, and Green agents.

6. Targeting. There are 124 distinct classes of targets in CAMPAIGN, referring not only to types of fixed facilities but also to more dynamic targets such as mobile missiles, aircraft, or troop formations. Damage from nuclear and conventional weapons is inflicted by attacking a CAMPAIGN target class and subclass within a given region. Strategic forces are targeted by assigning them to targeting plans, of which there are four types: a SIOP-like strategic nested attack plan (SNAP), theater strike plans, ad hoc plans, and strategic reserve. Weapons can be moved from one type of plan to another. Communications facilities, while identified as individual nodes, cannot be targeted directly. They must be targeted as a target class in a given region. Note that sabotage may be directed against an individual site using the "initiate" order.

7. <u>Damage Assessment</u>. CAMPAIGN uses a generalized battle damage assessment methodology for all conventional and nuclear weapons, modeling only blast damage. Targets sensitive to other means of damage must be converted to blast damage equivalent. C^3 facilities may be damaged by electromagnetic pulse and scripted (off-line) sabotage, while degradation from scintillation and jamming, can also be represented. The damage assessment model assumes that all attacks against a target class and region are distributed uniformly over these targets in the region. The attacker is not allowed bomb damage assessment or "empty hole" information.

8. <u>Inputs and Outputs</u>. The nuclear models draw their input from a wide range of sources including the basic RSAS input files for a description of the nuclear forces, the communications data files for C^3 location and connectivity, facility files for target data, weapon data and inventory from the weapons files, the information needed to build nested target options from the target file, the various parameter settings, and the model options to specify the models to be used in the current run. The user may then further modify the the models by designating an AWP, by issuing separate orders, changing setable parameters, or using the "use" option. Outputs include tabular displays such as damage summaries and force status, graphic displays such as a target summary and time-line charts, and output files.

9. <u>The Retargeter</u>. This interface with CAMPAIGN includes an upper level in which the nuclear plan in question is presented in the form of nested boxes, and a lower level in which a spreadsheet is used for detailed selection of weapons. The boxes can be changed,

modifying the nested subplans. An intermediate display permits the selection of weapons and target regions, and a final spreadsheet depicts weapons versus target regions. Weapons can be targeted against specific areas, with the changes subsequently sent to the CAMPAIGN models.

10. Parameters. There are several parameters in the nuclear models that can be adjusted and or selected according to the needs of the analyst. Major nuclear models include some twenty parameters that permit variable adjustment such as psi hardness of aircraft shelters, weapon CEP's, system mobilization rates, etc.. There are also model setting parameters such as selection of the nested plan and the bomber penetration model. These parameters have default values, and can be called from the Force/ CMENT window for a display of maximum/minimum/default values and a brief explanation of the parameter. Values can be accessed and changed through the "set" order, or use of the mouse "click and drag" via CMENT.

Part IV

CENTRAL EUROPEAN THEATER (CAMPAIGN-MT) MODEL

1. Introduction. Theater warfare modeling is probably the best developed aspect of the RSAS. The model has concentrated on the land/air war on the central front, with global escalatory, naval, and strategic nuclear force operations. Logistics support that could impact on the central front is to be improved later. The result is a reasonably reliable model of the central front, but an incomplete global model that needs to represent accurately these potentially significant contributions. Without these full capabilities to model areas outside of the European theater, the RSAS will be incapable of performing the types of simulations that are envisaged by the Navy.

2. Organization. The model follows Red divisions and Blue brigades along axes of advance/defense as specified in the analytic war plans (AWP's) using a roughly rectangular grid base superimposed upon the geographic features of central Europe. The simulation/model emphasizes the overall Red or Blue theater commander's perspective rather than that of the division or corps/army commander. The model tracks unit characteristics in some detail to include nationality, cohesiveness, composition, and level of training. The user can vary assumptions about a fairly broad range of issues to include national fighting effectiveness, maximum combat intensity, exchange ratios from prepared defenses, the effectiveness of close air support and helicopters in imposing attrition, and the delay, defense and attacker strategies.

3. Maneuver. The model allows the attacker and defender to maneuver at the corps/army level or higher. Axes for main thrusts, holding actions, follow-on attacks, and flank protection are all possible. There is also provision for the attacker to conduct a strategic level envelopment/encirclement (Red's preferred offensive), and for the defender to mount counter-offensives. The model uses phases of battle to include preparation, assault, breakthrough, exploitation and pursuit. Break-throughs, large local one-time losses, and operational maneuver groups in the defender's rear area may all be represented. One of the major strengths of the system is that Blue players are forced to confront a Red who engages not only in parallel opposing "pistons" but also with an envelopment/encirclement method of advance.

4. Air War. With regard to the air war, the model conducts operations for Blue squadrons and Red air regiments, handling sortie generation, mission planning, air-to-air combat, interdiction, and air-ground interactions to include close air support and battlefield interdiction. Air power can be used to defeat an operational maneuver group during the period of initial insertion. Carrier-based naval aviation can be used by the theater commander to supplement land-based tactical air assets in all normal air warfare missions.

5. Logistics. Logistics is played at a high level of aggregation by tracking days of supplies by nationality and permitting optional sharing of supplies. Movement of supplies is simulated

crudely, with each geographic zone having its own lines of communication trafficability and vulnerability. Movement through the zone can be reduced by interdiction. Strategic mobility deals with combat forces and support packages separately. Sea lines of communication are not currently fully modeled, making the logistical sustainability issue a major current problem area.

6. Naval War. The current model does not adequately perform amphibious landings, combined arms amphibious/airborne assault, defense against seaborne invasion, inshore mine warfare, or an accurate representation of the battle for the sea lines of communication. These deficiencies will need to be corrected before the RSAS can perform all the simulations of Navy interest. When the RSAS is fully developed, analysts will have a new opportunity to study the cross influences of war at sea to warfare ashore.

Part V

NAVAL WARFARE AND SUGGESTED IMPROVEMENTS

1. Naval Warfare. The naval combat models in RSAS conduct naval force simulations including antisubmarine warfare (ASW), anti-surface warfare (ASuW), and anti-air warfare (AAW) operations, attacks on land targets by carrier-based aviation and cruise missiles, battle group defense, at-sea engagements, shore-based strikes against battle groups, and limited mine warfare. Sealift is handled separately as part of the overall logistics effort. Coastal and amphibious warfare are modeled in part in CAMPAIGN-ALT, but are not well integrated with the major naval models. Individual ships are represented in the naval models, but operations are conducted and battle damage assessment (BDA) accomplished at the task group level. Naval engagements are conducted in accordance with rules of engagement (ROE's) prepared for Blue, Red, and Green. Combat results vary according to the forces present, the region and/or choke point. ASW includes the employment of submarines, maritime patrol aircraft (MPA), and surface ships, with emphasis on operations against nuclear powered submarines.

The naval models have been greatly improved in the past year, and are still undergoing refinement. Problems still remain, however, particularly with regard to the integration of the war at sea with warfare ashore. The models currently do not permit a full representation of battles over sea lines of communication, integrated air defense issues have not been settled, amphibious warfare is only partially played, logistics are not played at all

at sea, and naval command and control is not well represented. Sea-based aviation, ASW mines, ASW nuclear weapons, space assets, and operations by diesel submarines all need to be improved and/or added.

2. Location and Movement. Ocean areas in the RSAS are divided into 32 ocean regions, and 32 ocean subregions/chokepoints. Naval units are assigned to these ocean region/subregions unless they are in port, in which case they are assigned to a land region, thus allowing a distinction between attacks on maritime assets on the high seas and those in port or in internal waters. Naval forces may also be assigned by exception to a specific lat/long position; however, in most cases, units are actually assigned to the centroid of the ocean region, presenting location and movement problems, particularly if the region is large.

Naval units located in port are in varying stages of readiness, measured in the number of days delay imposed prior to getting underway. The delay can be reduced by ordering an alert, or by ordering a deployment. Submarine groups are generally deployed by assigning a station or launch location, and the submarine group will deploy the boats necessary to maintain the position. Other units are normally deployed by ordering the flagship to move. Routes for naval forces consist of paths from ports to operating regions. The RSAS chooses the most direct feasible route unless specifically instructed to use intermediate regions.

In the database, each ship is assigned to a class, with all ships in a class having the same general characteristics. Data

records are maintained for each ship, to include weapons capacity, ASW capability, sustainability data, and special weapons inventories.

3. Organization. Individual ships are assigned to task groups headed by a designated flagship. The task groups are subordinated to task forces and fleet commanders. The task group is the basic element for naval forces, and is named to signify its primary mission, e.g., carrier group, anti-carrier warfare group, convoy, etc.. Naval forces can be displayed in tabular form by individual ship or task group, by listing all forces assigned to an ocean region/chokepoint, or by listing forces assigned to a specific mission activity. Nuclear powered ballistic missile submarines are treated as strategic missile forces, and were described previously with the strategic models.

4. Deployment. Naval forces are organized and deployed in a mid-1985 force structure with Blue and Red strategies for employment paralleling those expected for the U.S./NATO and the Soviet Union/Warsaw Pact. The initial deployment of Blue forces is intended to be consistent with U.S./NATO maritime strategy. Initial Red employment emphasizes "bastion" defense. Green naval forces are deployed and operated in accordance with expected behavior of each individual nation. The RSAS allows the employment of forces in other possible modes; e.g., "swinging" forces from one major command to another, convoy escort instead of forward operations, interdiction of the sea lines of communication instead of "bastion" defense, etc..

5. Naval Combat.

a. ASW. ASW operations in the RSAS are modeled by the interaction among submarines, surface task groups and maritime patrol aircraft. Each ocean region and subregion/chokepoint is assessed regarding the presence of submarines and ASW forces and, if combat is authorized, capabilities versus vulnerabilities are computed and damage calculated for each side on a periodic basis, taking into account the general ASW related characteristics of the region. Adjustments are made, to a certain degree, for special sensors, diesel operations, ice conditions, and transit speed differentials. All ASW capable ships and aircraft are assigned capabilities relative to a baseline unit with engagement parameters. Relative capabilities are aggregated when multiple units are present, and attrition is distributed based upon relative vulnerabilities and current damage levels. Most parameters can be changed by the analyst using "script" commands as deemed necessary. Results can be displayed in several different ways: by region, by units, or by activity.

ASW activity can be initiated by Analytic War Plans, by an analyst-developed Control Plan, or by issuing Force orders. Force orders can be used to deploy forces, change operating areas, assign forces to new task groups or forces, and assign MPA to an ocean area. Combat is controlled by assigning ROE's to each ocean region, subregion or chokepoint to "attack, defend, withdraw, trail, or exclude".

b. Strikes Ashore. Naval forces can be assigned strikes on shore targets by the following methods: aircraft or missiles can

be ordered to strike a specific target; fighters and attack aircraft on board aircraft carriers can be assigned to launch flights in support of a theater commander; aircraft or missiles with nuclear weapons can be included as part of a "nested" nuclear plan. The carriers must be within range, of course, and sorties assigned to a theater commander will continue on a daily basis until unassigned or the carrier moves out of range. To perform strikes ashore, laydown packages of targets must be preplanned using the strike order.

c. War at Sea. Attacks on naval groups at sea may be carried out by opposing surface or air forces using conventional or nuclear weapons. In the model, these attacks must penetrate both an outer air defense and a close-in defense for each unit. In addition, defensive EW draws some missiles off, while the presence of surveillance supporting the attacking units tends to enhance the attack effort. Missiles are aggregated across the battle group with due regard for the effects of EW measures and prior target identification, and hit fractions are deducted from the total hit capacity assigned to each ship in the database. Ship performance is degraded for each missile hit. Unfortunately, procedures for generating these attacks are slow and cumbersome, and must be scripted or made part of a Control or Use Plan. Some default naval operations including shore-based air strikes against battle groups are programmed in RSAS 3.5, but naval plans, as well as naval command and control, need additional refinement. Attacks by Red shore-based air can be ordered against Blue battle groups, but, again, command and control is cumbersome, and the algorithms are still under development.

d. Mine Warfare. Mine warfare models place specific quantities of mines in chokepoints where they are likely to be placed, and attrite transiting shipping depending upon the ship's track in the minefield and the mine density. Sweeping can be ordered, but specific mine warfare units are not modeled.

e. Convoy Defense. Sealift convoys are attrited as they move across sea regions where convoy attack units assigned this mission are located, and using a relatively simple ratio of attackers to defenders to determine losses. Alternatively, a single fixed loss rate can be scripted for each sea region.

6. Input, Output, Parameters. Much of the input to the naval models comes from the database contained in the naval, ship, air, missile, weapons, and facilities files, unfortunately not consolidated into one "naval " file. Both inventories and capabilities are in these files as are many of the default parameters for kill rates, adjustments, etc.. Supporting geographic and routing data is in the database files as well. Units must, of course, be assigned their tasks by AWP's or specific orders. Displays include tables of forces and results of combat from CMENT, maps and graphics from the Graphics Tool, and most recently the world-wide display of selected naval forces on the "twirling globe" graphic. There are some 54 major naval battle parameters that can be set or tuned as required. Due to the highly aggregated nature of the naval models, the key parameters should be carefully examined and set by the analyst during the analytic process.

7. Asymmetries. It is important to remember the very different natures of the Blue and Red navies which present different

modeling problems. These asymmetries include the following areas: different objectives and style of maritime warfare such as the Red Navy's preference for sea denial and selective sea control in the maritime approaches to the homeland as opposed to the Blue Navy preference for forward deployment and long-range power projection; survivability in nuclear powered ballistic missile submarines in which Blue relies upon stealth while Red relies upon defensive "bastions"; at-sea tactical nuclear weapons capabilities; peacetime naval deployment patterns; forces and concepts of employment for naval aviation; command and control; the influence of the ground forces in the thinking and employment of navies; the differing capabilities of the allied navies; and the use of diesel submarine forces.

The RSAS has been developed with Blue/Red asymmetries in mind. The top down approach and the use of separate Red and Blue models lends itself to the development of the differing approaches characteristic of the Red and Blue sides. The RSAS also permits the use of special warfare phenomena that have been difficult to model in other systems. The global scope of the RSAS gives it a unique capability to reflect the breadth of asymmetries, described briefly above, and the abilities of navies to execute lateral excursions and escalation by fighting a more extended campaign.

8. <u>Improvements</u> <u>Needed</u>. Naval models in the RSAS have been greatly improved in the past year; however, there are still several areas where the models are not sufficient to meet NPS and Navy

requirements. All of these deficiencies have been communicated to RAND and OSD/NA. Some of the more obvious improvements needed include:

a. Strategic nuclear strikes against the shore from naval ballistic and cruise missile carriers from <u>all</u> nations that possess or might possess such a capability, and an ability to reload launchers where appropriate.

b. Active defense of strategic nuclear assets at sea by a combined arms defense by <u>all</u> nations that might employ such a strategy, or for all nations so that such a concept can be analyzed.

c. The full range of all current and programmed maritime nuclear capabilities.

d. Active attacks by <u>all</u> types of ASW forces, including at-sea ASW aviation against naval ballistic and cruise missile carriers, and attacks by the appropriate air defense forces (including naval) against the missiles. ASW capabilities must also be expanded to include space-based systems, communications intercept capability, and passive listening devices.

e. Strikes against the shore by Carrier Battle Group (CVBG) assets for all nations, full defense of the CVBG against a combined arms attack, recovery of assets by the CVBG, and reattacks against the shore targets.

f. Convoy operations in all ocean areas, including attacks against them from a combined arms force and a full defense.

g. Improved models for strategic sealift and logistics flow for <u>all</u> theaters of warfare.

h. Improved mine warfare, including modern ASW mines, using actual or estimated mine warfare units and inventories.

i. Amphibious warfare in areas where it is expected to occur in major campaigns, and where analysts might wish to test its impact; specifically against islands in the Baltic, Norwegian and Barents Sea, along the flank areas of NATO, and in the Pacific Far East. This should include the movement and escort of amphibious units including Marine air, attack and defense of these units and an opposed landing, if appropriate.

j. Although execution of expected maritime strategies as the normal default is proper, options must include all other major possible strategies: "swing," interdiction/defense of sea lines of communication, etc.

k. Faithful representation of actual areas of responsibility for U.S./NATO and Soviet/Warsaw Pact Commanders-in-Chief (CINC's) boundaries. For the classroom, it is important that actual names and boundaries be used vice artificial creations designed to ease modeling.

l. Major assumptions about vital strategic canals and waterways that are consistent with the assumptions made by the Joint Chiefs of Staff (JCS)/CINC's for planning purposes.

m. Political actions depicting activation of naval control of shipping world-wide and potential contributions of other nations.

n. Consideration of possible actions to be taken against Cuba in the event of a major war in Europe.

o. Strategies for a war focused on and originating in the Pacific. Global warfighting options must be improved.

p. In-depth operations in the Mediterranean, Baltic, North Sea, Norwegian Sea, Barents Sea, Sea of Japan, Sea of Okhotsk, Bering Sea, Arctic, etc., in support of the appropriate theater commander's objectives for each area of responsibility. These ocean areas are the ones that need to be improved with regard to locational capability and area ASW refinement. NPS desires to use these theaters to assess competitive strategies for war. In-depth bastion defense must be replicated.

q. Careful consideration of where the "sea" ends with regard to the question of escalation and control of forces. Simply put, naval forces that are attacked on the high seas will send a political signal that is different than if those same forces are attacked in territorial seas, historic/closed bays, internal waters, etc.

r. Escalation considerations must also include the asymmetries in the political sensitivities of certain areas of the world's oceans as expressed by different political actors, e.g., Red claims to ocean space and views on the right of access may not be the same as Blue or Green. A proper depiction of escalation with regard to maritime operations must account for operations taken in varying parts of the oceans; i.e., an attack on maritime assets in Soviet Arctic "zonal" sectors is probably more escalatory than an attack on that same asset in the mid-Pacific Ocean.

s. Escalation must also represent the different values assigned to different types of maritime assets. For example, an attack on a civilian registered/owned ship may bring one type of

response but an attack on a man-of-war may bring another. A fairly sophisticated accounting needs to be created listing ship ownership, crew, and registry so that actions taken against such assets involve the proper political actors.

t. Representation of drilling platforms and other such maritime assets needs to be added to allow for attacks against these structures. Nations are expected to respond to attacks on these types of assets.

u. Naval BDA currently spreads fractions of damage over the entire battle group. A more detailed assessment may prove too expensive and self-defeating for the overall purposes of the RSAS. Scripted battle results, however, might specify details not actually captured in the models to lend credibility, e.g., a carrier battle group might have its combat potential reduced in the models as the result of an attack but the displays might state carrier radars out of commission, flight deck damaged, etc. In any case, defensive capability should degradate in stages, not just all at once when a ship is sunk.

v. Although the RSAS is not a tool for tactical analysis, the current lack of geographic coordinates for naval force strike orders undermines credibility.

w. ROE's must vary by oceanic/land region; e.g., the rules allowing attacks on enemy naval forces should not be the same if the unit is on the high seas as they would be if the unit is in port. Also, the rules may not be the same in the Pacific if the war is thus far confined to the Atlantic.

x. Surface-to-surface warfare engagement, and command and control improvements are needed. Surface-to-air warfare needs to

treat fighters as something other than just long-range surface to air missiles. Surface-to-air warfare needs to account for multiple engagements of incoming aircraft or missiles (layered defense). Short-range surface-to-air missile capability may be too ambitious.

y. Cruise missile attacks on battle groups or convoys should not assume a uniform spread across all ships in the formation. Great efforts are made by the attacker to ensure that the high value units are hit first, while defensive measures are taken by the defender to protect these high value units. The latest models attempt to cover this problem by assigning greater effort against the key targets in the battle group while diminishing some of this effort with appropriate EW defense.

z. Timely and routine updating of databases is essential. Names of ships and squadrons are less important than good numbers and locations. Adding programmed Blue forces, and projected Red and Green forces for 1995 should come as soon as possible. The current plan for a 1965, 1975, 1985, and 1995 database is supported, with other years to follow. The addition of CACI Products Company as part of the effort on the database situation should help alleviate this problem.

aa. The Navy is currently assessing the capability of large floating offshore platforms to provide a viable alternative to bases ashore overseas. RSAS planning should be considering modeling such a capability for afloat logistics and and other support as an alternative to bases and ports.

9. <u>NPS Projects</u>. NPS intends to address this lack of depth in naval warfare by identifying the problem areas through the use of RSAS studies and runs in support of NPS research efforts and student seminars, and attempting to make informed recommendations for improved algorithms and models using the extensive naval expertise available at NPS. NPS researchers have already participated in most RSAS Working Group sessions, and have produced studies addressing specifically the naval model problems. In addition, NPS intends to use the RSAS to measure the impact of the war at sea upon the war ashore, and to demonstrate where the lack of naval models makes other forms of combat analysis fatally flawed. The Navy and NPS need a fully developed working model from the RAND Corporation that covers the broad spectrum of naval warfare involving all nations around the world that have navies. Primary emphasis should first involve strategic nuclear issues and the conduct of war in Europe, to include the flanks, since these models are the best developed. All other areas of the world should be developed on a lower priority. Navy and maritime models must be made an integral part of the strategic and European war models, not simply just an adjunct.

Part VI

OTHER THEATER (CAMPAIGN-ALT) MODELS

1. Organization. CAMPAIGN-ALT is a flexible model of land and air warfare in theaters of operation outside of the NATO Central Front in Europe, and the Korean area. The model is organized as a network with key theater locations as nodes, and lines of communication (LOC) as arcs. In some cases, a point node may not have any LOC arcs, such as on islands. The theaters represented in CAMPAIGN-ALT thus far include Scandinavia (Norway, Sweden, and Finland), the Baltic islands of Zealand and Bornholm, Greece, and Turkey. There is a modest model representing Southwest Asia. Iceland, Cuba, Italy, and Yugoslavia are under development. A limited interaction with naval forces (generally scripted) is available, although coastal forces are modeled in some detail. CAMPAIGN-ALT depends upon the following three programs to execute: analytic war plans (AWP's) in RAND-ABEL, a referee model also in RAND-ABEL, and a force adjudicator or "scripter" written in "C." AWP's provide instructions to the model regarding what each side is supposed to accomplish under various conditions. Ground and air forces are assigned and deployed to specific theaters and axes of operations. Naval air may be assigned for use, and deep operations may be ordered.

2. The CAMPAIGN-ALT War. A local ground commander module assesses the situation as action progresses, and dispatches units according to need. Each LOC and node have values, and the composite theater status is determined by the status of the most important

LOC's and nodes. Damaged targets are repaired at a fixed rate of five per cent per day. Key and strategic events have been defined to assist in assessing the progress of the engagements. These include the loss of a capital, the cut-off of forces along a LOC, and the loss of key nodes. Bases are considered closed when the level of damage exceeds 50%.

Combat adjudication is assessed by the referee, and results passed to the CAMPAIGN-ALT force adjudication model. Combat results are based upon results from previous studies extrapolated to fit the area being simulated. Part of this process occurs in the referee module and part in the force adjudication model, e.g., if air superiority has been gained by one side, this will have an affect on the movement rate of the forward leading edge of troops (FLOT). Seasonal modifiers built in to the modules affect FLOT movement rates, air sorties, and loss rates in specific areas being simulated.

3. Graphics. CAMPAIGN-ALT has a series of sophisticated graphics to support it. A map can be called up which depicts the theater, color coded to indicate nodes and LOC's under friendly or enemy control. Windows can be called up for the various LOC's and/or nodes indicating their status. Forces assigned can be called by keying on the appropriate node, LOC, or sea area.

4. Deep Operations. The referee model assesses the results of deep operations and the impact that the operations have on the rest of the war. Deep operations currently include airdrop, air-reinforce, heliborne, amphibious, sea-reinforce, unconventional warfare, and chemical strikes. Several factors are assessed in

determining the outcome of these operations: air control, surprise, and defending forces. Missions include occupy or denial in most cases. Battle damage assessment is a function of mission type and success. Types of targets include national capitals, airfields, ports, stockpiles, key facilities, and LOC chokepoints. Each target is updated regarding the degree of enemy/ friendly control and the amount of damage sustained.

5. Improvements Needed. Future versions of CAMPAIGN-ALT should permit representation of all seaborne and airborne forces contained in the RSAS data base, permitting the analyst/player to change the use of these unique forces as required rather than having to preset them before the start of the war. Additional flexibility is needed in the assessment of capabilities of airfields, e.g., when battle damage is sustained. Also, a compact method of addressing all relevant CAMPAIGN-ALT parameters from a single location is planned, so that the analyst need not enter different processes to make changes. There is no logistics representation in the current model. CAMPAIGN-ALT should include logistics at least to the extent that it is played in CAMPAIGN-MT.

Amphibious warfare needs to be improved as does the interface with other aspects of naval warfare. Amphibious operations currently amount to little more than force additions to the ground war, and the naval interface is primarily an aggregated relation to the local coastal situation. Connections between CAMPAIGN-ALT and the rest of the strategic portions of the RSAS need to be improved so that all CAMPAIGN-MT events will have an impact upon CAMPAIGN-ALT. NPS users recommend that CAMPAIGN-ALT

not be developed to support testing minor secondary land theaters at the expense of strategic nuclear and European theater needs, including the missing naval components. The RSAS was originally conceived as a global, macro-level model. Where CAMPAIGN-ALT can be shown to be necessary to represent European flank campaigns accurately as part of the NATO war, then priority should be assigned there.

Part VII

INSTALLATION AND USE OF RSAS AT THE NPS

1. Installation. The RSAS Sun installation in the NPS WARLAB consists of two Sun 3/60 color microworkstations with 16 megabyte random access memory (RAM) each, a Sun 3/180 file server with 16 megabyte RAM and a black and white monitor, a 575 megabyte hard disk, a 1/2" high density tape unit, a color printer, and a black and white laser printer. This equipment is in the process of being linked together via ethernet to provide a networked system with at least three monitors for research flexibility and for Red/Blue/Control war gaming. Items still required include a large screen display to support lectures and briefings, and back up hard disk capacity. The Operations Research (OR) Department WARLAB provides power and the electronic and physical security for the system. The NSA Department provides administrative security, and software/hardware support. Additional details regarding the installation and required enhancements are contained in Appendix D.

2. Use of RSAS. It is anticipated that the RSAS will find multiple uses at NPS subject to the Standard Operating Procedures (SOP) contained in Appendix A, the security restrictions and release procedures outlined in Appendix B, and the agreements for mutual support in Appendix C. Potential users must understand that mastering the RSAS is a process which should be expected to take up to four weeks of concentrated training and up to six months of full-time hands on experience.

a. The National Security Affairs (NSA) Department will provide a professor who is knowledgeable about the Sun microworkstation and the RSAS. This individual, the RSAS Administrator, will control access to the RSAS microworkstations in accordance with the SOP guidance provided in Appendix A and on a not-to-interfere with sponsored research basis. The RSAS Administrator will assign passwords, file space, give machine instruction, and will act as primary liaison with the RAND Corporation and its subcontractor, currently CACI Products Company, for all technical issues.

b. Primary RSAS use, naturally, is in support of sponsored research performed by faculty members whose research accounts have paid for the hardware and training of personnel. All other use of the system is on a not-to-interfere basis. It is expected that additional faculty and staff, including faculty from departments other than National Security Affairs, will be able to use the RSAS as a teaching aid for courses and classes in general, and specifically for nuclear strategic planning, strategy, net assessment, threat assessment, gaming and simulations, and intelligence. When the RSAS is used to support instruction for any curriculum, the faculty member responsible for the specific course/class will first be given a copy of this report, then a short orientation briefing at the Sun microworkstation, and will be asked to determine how RSAS use would best fit the needs of the course/class. The RSAS Administrator will then perform whatever runs are required (on a not-to-interfere basis) and the results will be returned to the students in the form of a briefing/presentation, to include any necessary charts and graphics.

This would be followed by a critique, and further runs as desired by the faculty member. It is not anticipated that any faculty/staff members, other than those specified in sponsored research already involving the RSAS, will be trained to operate the system due, primarily, to the lengthy training time required to master the system.

c. Student participation in the form of thesis projects which will make use of the RSAS is especially encouraged. It is not anticipated that any student will have the time to be trained as an RSAS operator for seminar or other class papers. Students who desire to use the RSAS for thesis research and their two faculty advisors will first be given a copy of this report and a short briefing/demonstration of the system. The faculty advisor and student will then be asked to explain to the RSAS Administrator what use of the system they desire. The RSAS Administrator will perform whatever runs are required (on a not-to-interfere basis), and the results will be returned to the student in the form of a briefing/presentation, to include any necessary charts and graphics. This would be followed by a critique, and further runs as desired by the student and advisor. The student, and the advisor at least initially, should be prepared to be present in the WARLAB as the runs are made to assist in scoping the effort. RSAS printouts or data runs will normally remain in the WARLAB. If it seems necessary to remove them from the WARLAB, they will be marked as a classified working paper, will be assigned a control number, and will be returned to the WARLAB for disposition.

d. Other faculty may be able to use the RSAS for their own research, again subject to standard restrictions, and on a not-to-interfere basis with on-going research and use of the system in support of instruction and thesis research. If adjudication is necessary, the RSAS Principal Investigator will make any necessary rulings.

e. Although the RSAS is available for student and faculty research and instruction, and such use is encouraged, it must be kept in mind that the information in the RSAS is SECRET/NOFORN/WNINTEL/NO CONTRACT overall, and that these restrictions must be carefully observed. Any reports which make use of the RSAS must be submitted through proper channels for security review. The NSA Department, through the RSAS Administrator, will provide advice and guidance regarding classification and release. Additional details regarding security and release are contained in Appendix B.

PART VIII

OPPORTUNITIES FOR RESEARCH

Opportunities to support research at NPS are as follows: any U.S. government sponsor can provide lists of topics that it desires students or faculty to research in the future. The Office of the Chief of Naval Operations (OP-06) and the Air Force Institute of Technology (AFIT) have already done this. Student thesis topics are of the student's own choosing, as long as they meet the necessary educational skill requirements, although students are encouraged to select topics that their sponsors desire. The obvious drawback is that NPS cannot "guarantee" that a topic will be researched by students nor completed by a particular date.

Individual research desires and the ability to obtain sponsorship from DoN, DOD, or any other sources tends to complicate the topics selected by the faculty for research. Each civilian faculty member at NPS is normally hired for ten months. The faculty member is expected to obtain sponsored research for the remaining two months or take two months off without pay. The faculty are naturally drawn into areas where a sponsor is willing to provide resources. NSA faculty have been extremely interested in the past in doing Navy-relevant research, but have not always been able to find a Navy sponsor who can provide study money.

The lack of study money in OP-06 and a relatively modest research budget within Naval Intelligence for research at NPS has resulted in NSA faculty being drawn to research areas that lie outside of those areas of normal interest to these two sponsors.

When faculty research moves into one area or another, student research in the form of theses generally follows. Put another way, sponsored research generally results in additional student research at no additional cost.

During FY-88, the Navy set up a new direct funding program for all Navy research. Under this program, Navy research money was not allowed to be sent from a Navy sponsor directly to NPS; these funds were provided directly to the school in the budget. The National Security Affairs (NSA) department obtained some of this block funding and has an FY-89 research program already on-going. No Navy sponsor had to send additional money to NPS under this arrangement. Instead, money was provided by NPS to the faculty member acting as Principal Investigator, if that faculty member was able to locate a sponsor who agreed that the work ought be done. For FY-89, the Office of the Chief of Naval Operations (OP-603) sponsored RSAS work at NPS. Since there were more faculty members at NPS who desired access to study money, NPS could not fund all research proposed by the faculty. Generally, those funded were those whom the sponsor not only agreed that the work needed to be done, but also that the work was of major importance to the Navy.

Proposals to perform Navy research under a continuation of this direct funding program in FY-90 and beyond have been prepared by NSA faculty members at time of this printing. Identifying policy relevant projects to be done one year in advance is extremely difficult. During the last cycle (FY-89), most sponsors wanted to change the terms of reference at the last

minute and thus marked the original proposals sent to them as no longer of interest. Unfortunately, the net result of this was to cancel some projects for one entire year. An NSA department objective for the future is to find additional research sponsors who understand the unique opportunities for RSAS and other related research at NPS. For example, if a sponsor is interested in seeing NPS faculty perform research using the RSAS, a general proposal for work should be crafted with the understanding that upon execution (1 October 19XX), the sponsor will identify more specifically what is to be done during the next year. This will require that all officials in the sponsor's office understand why proposals are written the way they are so that they are not rejected at the last minute for being "vague."

Another vehicle to sponsor research at NPS is to transfer funds from a non-DoN activity to NPS. A Military Interdepartmental Purchase Request (MIPR) can be used, for example, to transfer money from DNA or OSD/NA to NPS. In such cases, DNA or OSD/NA will act as the official sponsor. This vehicle is the only way to sponsor additional research for FY-90 since all Navy monies have been obligated. This scheme might also be the one required if the current direct funding system is terminated in the future. DNA is currently sponsoring research using the RSAS at NPS for FY-88 through FY-90.

Potential sponsors should contact the RSAS Principal Investigator or the RSAS Administrator (the authors of this report) at AVN 878-2521 or (408) 646-2521 to discuss opportunities further. There has been discussion of using the RSAS to support the Strategic Think Tank (STT) being formed by the Navy to be located at

the Center for Naval Analyses (CNA). The terms of reference for the STT signed out by the Vice Chief of Naval Operations on 24 November 1987 included supporting work to be performed by NPS. Follow-through will have to include transfer of funds to NPS to sponsor such efforts.

Appendix A to RSAS Report

SOP FOR RSAS USE AT NPS

1. The RSAS is primarily a research and teaching tool designed to analyze planning on the broad "strategic" level. It is not a machine for evaluating specific weapons systems. The analyst must be prepared to spend a considerable amount of time to set up specific control plans, to learn enough about the system to be able to make changes in the data base, and to modify the rules of the various force structures. RAND estimates that mastering the system requires at least four weeks of concentrated training, and up to six months of full time hands-on experience. Naval Postgraduate School experience validates this estimate.

2. The RSAS is located in the Wargaming Analysis and Research Laboratory (WARLAB) in Ingersoll Hall. Physical security is under the control of the security specialist assigned to the WARLAB. Access to the RSAS itself is under the control of the RSAS Administrator, normally the senior RSAS analyst/lab technician assisting the Principal Investigator in the National Security Affairs (NSA) Department. Individuals desiring to use the RSAS for research, studies, thesis preparation or classroom support will initially discuss their proposal with the RSAS Administrator, and will be given a copy of this report for study and a short orientation briefing on the RSAS. The individual will then be requested to determine how RSAS use would best fit the needs of the project under investigation, and to advise the RSAS Administrator of the type of data and/or runs required. The RSAS Administrator

will ensure that the necessary runs are performed, and will provide the results to the individual. The individual desiring the RSAS runs should be prepared to be present in the WARLAB while the runs are being performed to provide advice on the project. Printouts and data runs from the RSAS will be marked according to classification, and will normally remain in the WARLAB. If it bcomes necessary to remove them from the WARLAB, they will be marked as a classified working paper, will be assigned a control number, and will be returned to the WARLAB for disposition. Conflicting priorities for RSAS and operator time that cannot be resolved will be referred to the RSAS Principal Investigator.

3. It is not anticipated that any faculty/staff members, other than those specified in sponsored research already involving the RSAS or hired directly to support the RSAS as a part of the NSA Department laboratory package, will be trained to operate the system, due to the time involved in training and the sensitivity of the information in the RSAS.

4. In the case of those individuals who have been, or are to be trained on the RSAS, the RSAS System Administrator will provide system access, checkout, and briefings as needed. Individuals requiring access to the RSAS must contact the WARLAB security specialist for the proper procedures to gain entry to the WARLAB spaces.

5. While the Sun workstations used by the RSAS are under the control of the NSA PI, they are located in the WARLAB and must

take into account the WARLAB scheduling process, which includes quarterly scheduling sessions, a distributed quarterly schedule, and current changes posted in the WARLAB. The RSAS schedule is part of this process. The RSAS Administrator will referee any problems concerning access to the RSAS as needed, and will be available for technical assistance as much as possible.

6. The RSAS is a SECRET NOFORN WNINTEL NO CONTRACT classified operation, as covered in Appendix B for security and release. Much of the information regarding intelligence and planning is very sensitive, warranting close protection. Requests for downgrading and declassification must be reviewed by the RSAS Administrator prior to forwarding via the proper channels for these purposes.

7. Individuals working on additional new research grants and requiring RSAS support will be expected to contribute in accordance with the following guidelines:

a. pay own salarv and travel;

b. pay a prorated portion of the maintenance, supplies, and other consumables;

c. pay for any upgrades that might be required for their project; and

d. pay a prorated portion of the RSAS Administrator or Laboratory Technician salaries, if a significant amount of their time is involved.

8. Use of the RSAS is highly encouraged among the faculty and students. The Department of Defense has expended a significant

amount of funding on this project, and it represents an elaborate system which should be used to good advantage here at the Naval Postgraduate School.

Appendix B to RSAS Report

SECURITY AND RELEASE PROCEDURES

1. The RSAS contains information extracted from the best available intelligence, and from sensitive U.S. planning procedures. It is essential that certain restrictions be observed with respect to protecting the classified material contained in the various models and data bases that are part of the system. In accordance with guidance determined by the RSAS Steering Group and promulgated by the Director of Net Assessment in the Office of the Secretary of Defense, the RSAS runs at the SECRET NOFORN WNINTEL NO CONTRACT level. Access is currently limited to U.S. Government employees. Contractor access to the RSAS is limited to RAND and one RAND-selected subcontractor, currently CACI Products Company. Consultants are not exempt from these rules. Access at NPS will not be granted automatically to any individual who has the appropriate clearance; need to know must be established to the RSAS Principal Investigator's satisfaction.

2. Students, faculty, and staff of the NPS using the RSAS for research or analytical support purposes in preparing studies, papers, theses, etc., must classify the appropriate sections. RSAS printouts and data runs will be classified and marked according to content, and will not be removed from the WARLAB. If it bcomes necessary to remove them from the WARLAB, they will be marked as a classified working paper, will be assigned a control number, and will be returned to the WARLAB for disposition. Studies that make use of the RSAS intended for open

publication must be submitted to the appropriate clearance release authorities, and must be approved for release prior to unrestricted distribution.

3. The NPS RSAS Administrator will provide advice and assistance regarding any RSAS related material for which downgrading or declassification authority is desired. An appropriate request will then be made, as necessary, through the normal chain for such matters.

4. The RSAS Administrator will maintain a list of individuals authorized access to the RSAS, and will make the necessary arrangements for access and passwords. The WARLAB provides physical and electronic security for the RSAS. Arrangements will also be made for an RSAS procedures guide and a use log. Individuals making use of the RSAS will be instructed regarding security constraints as outlined in this appendix, and in the use of the procedures guide and the use log.

5. It must be kept in mind that the RSAS is a joint strategic net assessment tool, and thus contains classified information that is within the purview of all the services and intelligence agencies. The sensitivity of the information within the system must be observed.

Appendix C to RSAS Report

IDSA for Maintenance, Security, and Use

1. The National Security Affairs (NSA) Department, the Operations Research (OR) Department, the Director of Wargaming, and the Wargaming Advisory Committee agree to the following procedures for the use, maintenance and security of the RSAS:

a. The recognized, prioritized list of operations which are conducted in the Wargaming Analysis and Research Laboratory (WARLAB) is as follows, in priority order:

(1) Classroom wargame laboratory sessions and preparation.

(2) Student and faculty research, to include resultant thesis and report preparation.

(3) General classified word processing and computation analysis (a recognized ancillary capability of the resident systems).

(4) Other DOD research and activities, to include resultant report preparation.

b. The WARLAB Technical Director will manage the provision of space on laboratory machines and floor space for peripherals to support the operation of the RSAS as a recognized project under category 1.a.(2) above. Normal SECRET level physical and electronic security will be provided by the existing plant and security procedures as currently published. Additional procedures for the RSAS to meet the specialized requirements of SECRET NOFORN WNINTEL NO CONTRACT, as directed for the system by the RSAS Steering Group and the Director of Net Assessment, Office of the Secretary of Defense (OSD/NA), will be observed through adminis-

trative arrangements between the WARLAB Technical Director and the NSA RSAS Administrator. This will include visitor control and physical access to the Sun workstation.

c. The NSA Department will provide a knowledgeable professor, normally the senior RSAS analyst, who will be designated the RSAS Administrator. The RSAS Administrator will be trained in RSAS matters and in Sun system administration, will give advice and assistance on RSAS security matters, will maintain administrative access security to the RSAS by the use of passwords and the normal UNIX security system, and will provide indoctrination and control for RSAS users. The RSAS Administrator will be eligible for and authorized access for certain SCI and compartmented clearances in order to maintain a full comprehension of all RSAS capabilities.

d. Primary access control to the space containing the Sun workstation which hosts the RSAS will be through scheduling dedicated time. At other times, when dual use of the space is required, the Sun monitors will be screened from viewing by others in the WARLAB while the RSAS is being operated.

e. Scheduled war games for classroom instructional support on any system in the WARLAB will take precedence over any other activity in the WARLAB. Whenever possible, RSAS analysts will be permitted access to the Sun workstation when such access will not interfere with the progress of a scheduled wargame. RSAS analysts will be cleared for at least Secret, so their presence should not hinder the progress of any regular lab war game. Any other priority conflicts will be handled by the Technical Director and the RSAS Administrator, with adjudication by the RSAS Principal

Investigator and the Director of Wargaming, the OR Department Chairman, and by the Naval Postgraduate School appeal process, if required.

f. The Technical Director will administratively manage the contract of the necessary Sun hardware and Sun software maintenance support. In the near term, the purchase of maintenance services may be necessary while additional experience is gained with the system. The primary concept for the future will be the establishment of self insurance through the purchase of redundant critical components to preclude costly maintenance services. The NSA Department will provide reimbursement for a proportional share of this cost, to be arranged by the Principal Investigator and the Director of Wargaming. The NSA department will provide all RSAS software support and unique RSAS hardware requirements.

g. Individuals working on additional/new research grants and requiring RSAS support will be expected to contribute on a pro-rated basis to RSAS costs. Additional details are as covered in the RSAS standard operating procedures (SOP) contained in Appendix A.

h. The NSA Department will make the RSAS available to the WARLAB to be used in support of WARLAB war games, subject to the coordination required through the RSAS Administrator and the Principal Investigator, as covered in the RSAS SOP contained in Appendix A.

SIGNATURES:

NSA DEPT CHAIRMAN:

OR DEPT CHAIRMAN:

WG ADV CMTE CHAIR:

DIR OF WARGAMING:

RSAS P.I.:

RSAS ADMINISTRATOR:

Appendix D to RSAS Report

RSAS HARDWARE INSTALLATION AT THE NAVAL POSTGRADUATE SCHOOL

1. Current Installation. The current RSAS hardware inventory, as of June 1989, consists of two Sun 3/60 micro workstations with a color monitor and 16 megabytes of random access memory (RAM) each, one Sun 3/180 file server with a black and white monitor and 16 megabytes of RAM, a Fujitsu "Super Eagle" 575 megabyte hard disk, a 1/2" high density 6250 bpi tape drive, a Textronics color printer, a Sun (Apple) laser printer, plus cables, racks and stands. The Sun workstations and the file server are being linked together via ethernet. The large disk, the 1/2" tape drive, and the file server are installed in a Sun rack in the WARLAB equipment room, as are the printers, while the monitors are located in the WARLAB working area. In addition, there is a Tempested Zenith desktop computer in the NSA spaces in Root Hall available for preparation of faculty and student RSAS related studies and theses. As a matter of mutual interest, the WARLAB has in its inventory two Sun 3/160 micro workstations with two 71 megabyte SCSI disks each.

2. Future Requirements.

a. Workstations and Hard Disks. The current Sun workstation inventory allows use of the system by two analysts at any given time, and permits basic scripted RSAS war games. The black and white monitor that controls the file server can be used for limited access only, especially when the server is under heavy tasking. To make full use of the RSAS capabilities in the future,

one additional workstation is required. This will permit multiple use for analytic purposes and the ability to play two sided war games (one monitor each for Red, Blue, and Control/Green). To provide for redundancy in case of hard disk failure, an additional hard disk with 380 megabyte capacity has been ordered. This disk will be removable to meet security requirements that have developed since installation of the original RSAS at NPS. Another 380 megabyte disk is needed when funds are available to improve the backup capability.

b. Large Screen Display. It has become increasingly apparent that a large screen display device is essential to provide proper presentations to classes, briefings, and seminars. It is preferable that this large screen display be located in a secure classroom due to overcrowding in the cramped spaces of the WARLAB, and that the RSAS data be transmitted using fiber optics cables and a Tempested workstation for security reasons. Currently, the display of RSAS data is limited to a maximum of four individuals "huddled" around a workstation monitor.

c. WARLAB Power Upgrade. Additional equipment has been added to the WARLAB, including the RSAS Sun installation, to the point where the power supply into the secure space is not sufficient to operate all of the equipment. Additional funding is needed to prevent a sudden power outage which tends to destroy some of the software if it is being manipulated under the UNIX operating system.

d. New Building. The WARLAB spaces are becoming exceedingly crowded and, as noted above, additional room is needed to mount a large screen display and Tempested workstations for briefing and

classroom instruction. New power lines are required to prevent power outages in the WARLAB. Moving the RSAS into a secure space in the new Building "A" would provide for improved instruction and utilization of the RSAS equipment, and would save the cost of the power upgrade, the fiber optics cables, and the Tempested workstation.

4. Maintenance Required. RSAS software maintenance will be provided by RAND and its subcontractor, CACI Products Company, as arranged by the Director of Net Assessment in the Office of the Secretary of Defense (OSD/NA). Each RSAS "player" was required to contribute $23K for FY-89 for this support, and will be required to contribute about $30K for FY-90. Subsequent arrangements for RSAS support will be the responsibility of the RSAS Principal Investigator. With regard to the Sun workstations, it is intended that the basic maintenance will be through redundant units in order to lower the cost. Certain single items such as the large hard disk may require some maintenance support with Sun Microsystems. There is currently no repair maintenance capability in the WARLAB for the Sun's beyond what has been learned during installation, i.e., NPS personnel can remove and replace boards, and check basic DIP and backplane settings. There are several repair alternatives, but the best seems to be the telephone type of maintenance, in which phone consultations can be held with Sun, and parts pulled and returned for replacement via mail. Since Sun is relatively handy (Santa Clara and Milpitas), this arrangement should not present any insurmountable problems, and is much cheaper than on-site support (about half the price).

Unfortunately, due to the presence of classified information on the hard disks, their maintenance cost is higher than normal. If Sun workstations proliferate at NPS, closer support might be more cost effective in the future.

5. Sun Software Support. Software support for the Sun workstation is also required. The RSAS workstations must use the Sun operating system release currently being used at RAND, and not necessarily the latest Sun release. For example, the workstations are currently using RSAS release 3.5 which is based upon Sun release 3.5. The latest Sun release on the market is 4.0.1, and 4.1 is about to be issued. It is anticipated that RSAS 3.7 will be released later this year based upon Sun release 4.0.1. Clearly, not all Sun releases are required, so it appears that ad hoc purchases, probably about once each year, are the best policy at this time. RSAS users will need to follow RAND's lead and purchase only those Sun releases that RAND implements. It is anticipated that multiple licensing arrangements will lower the cost of operating the Sun workstations as they proliferate at NPS.

7. Summary of Programmed/Recommended Additions. In summary, the following hardware/software additions are recommended:

Hardware:

Immediate requirement:

* Backup hard disk	$ 4,900
Power line installation (WARLAB)	$ 12,500
Large screen display	$ 21,000
Fiber optics cables	$ 4,000

Longer term:

Sun hardware maintenance for Super Eagle hard disk	$ 400	(apprx per mo)
Sun 3/60C-16 diskless worksta	$ 12,500	
Removable backup hard disk	$ 3,500	
Sun 3 tempested workstation	$ 30,000	

Software (essential):

* Sun O/S release	$ 3,000	(apprx per yr)
RAND/CACI support	$ 30,000	(apprx per yr)

* items currently on order.

8. Installation Summary. The current installation provides a basic capability to conduct research and to run elementary war games on the RSAS. The addition of the equipment already on order or urgently needed will enhance the present installation, will permit large-scale briefings and group instruction, provide for more flexible use, and permit improved research and gaming. The purchase of the long-term equipment will provide excellent flexibility in research for both students and faculty, and will support the basis for the operation of highly sophisticated war gaming. Secure space in the new Building "A" would provide much improved working conditions and would preclude the need to fund several expensive items required for proper RSAS utilization.

Appendix E to RSAS Report

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